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Review

The Evolving Role of Continuous Glucose Monitoring in Hospital Settings: Bridging the Analytical and Clinical Needs

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Abstract

Background: The use of continuous glucose monitoring (CGM) offers several benefits. Compared to point-of-care (POC) capillary glucose tests, user acceptability is greater, and time in the target glucose range is improved. If these advantages can be transferred from outpatient to in-patient settings, CGM could assist clinicians in making timely, proactive treatment decisions. **Scope of the review**: This scoping review focuses on clinical studies of CGM use in hospital settings among non-pregnant adults, with a particular focus on studies from 2023 to 2025. It examines the latest evidence and guidelines and sets out the clinical and analytical considerations involved in implementing in-patient CGM. **Main findings**: In-hospital CGM facilitates hypoglycemia detection, especially asymptomatic and nocturnal episodes. Data on the impact of CGM use on clinical outcomes are scarce, and most studies focus on the reliability of CGM technology rather than clinical outcomes. Several factors affect CGM accuracy in hospitals, such as medications, fluid management, and hemodynamic disturbances. Despite between-device and settings-related variability, CGM devices generally show reasonable accuracy, with Mean Absolute Relative Differences (MARDs) ranging from 10% to 23%. In-hospital CGM has also improved workflows and reduced personnel exposure in infectious disease settings. **Key implementation challenges**: The MARD thresholds for safe in-hospital CGM use without confirmatory POC testing and evidence-based protocols for CGM application in ICU and non-ICU settings are not yet established. Despite challenges related to implementation, including personnel training, integrating diabetes technology with electronic health records, and costs, the benefits of improved monitoring and in-patient safety make CGM use worthwhile to pursue.

Keywords: continuous glucose monitoring (CGM); in-patient diabetes; glucose sensing; in-patient diabetes technology; peri-operative care; intensive care; medical in-patients; mean absolute relative difference (MARD); CGM accuracy

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1. Introduction

Continuous glucose monitoring (CGM) is a rapidly evolving, impactful diabetes technology that provides interstitial fluid glucose concentrations at regular 1–5 min intervals via a subcutaneously placed sensor. Since the introduction of CGM technology in 1999, CGM devices have enabled easily accessible monitoring of glycemic excursions and several additional glucose metrics [1–3]. The widespread adoption of CGM for outpatient management has established these sensors as the standard of care for individuals with type 1 and

type 2 diabetes who use insulin, and has recently spread to those on non-insulin therapy, as well as individuals with dysglycemia [4]. This has led to an increase in the number of hospitalized patients who use CGM devices. The COVID-19 pandemic accelerated the adoption of CGM in hospitals and offered valuable insights for its implementation [5–7]. However, guidelines still recommend confirmatory point-of-care (POC) glucose measurements for insulin dosing and hypoglycemia assessment [8–11]. Studies generally suggest that CGM could eventually replace traditional fingerstick tests for carefully chosen clinical environments [1,3,5,6,12–20]; however, further studies and regulatory approvals are still needed [10].

The level of glycemic control in hospitalized patients significantly affects the length of hospital stay, and multiple studies have associated dysglycemia with higher morbidity and mortality in both critically ill and non-critically ill patients [21,22], as well as in patients undergoing elective surgery [23–25]. Glucose monitoring and management are parts of standard care in hospitalized persons with diabetes (PwD) [9,26]. On admission, to assist with in-patient treatment and discharge planning, HbA1c should be measured for all PwD and individuals with dysglycemia [9]. In modern diabetes management, the need for a shift from a reactive approach—based on HbA1c, to proactive glycemia management with standardized monitoring is encouraged in both diabetic and non-diabetic individuals [27]. This can be achieved by outpatient and in-hospital CGM use [28].

The term *in-hospital CGM* is used inconsistently across published literature. It is used interchangeably to describe PwD who are already familiar with the technology and continue its use while admitted, as well as new patient onboarding (starting CGM in a hospitalized patient). These may be individuals with type 1 diabetes, type 2 diabetes, or even stress hyperglycemia. These factors make generalizing findings difficult.

This scoping review provides an overview of in-hospital glycemic monitoring, maps current evidence, and outlines clinical and analytical considerations for in-patient CGM use. It discusses typical scenarios in which CGM can be useful and potential obstacles to seamless in-patient CGM adoption.

2. Methods

References for this scoping review were identified through database searches of PubMed and Google Scholar, with the most recent search conducted in November 2025. The focus was placed on clinical studies published within the last three years, with key studies identified to map the evolving literature and highlight research gaps. A combination of Medical Subject Heading (MeSH) terms and non-MeSH terms was used, including continuous glucose monitoring (CGM); in-hospital CGM, in-patient diabetes; glucose sensing; in-patient diabetes technology; peri-operative care, intensive care, medical in-patients, mean absolute relative difference (MARD), CGM accuracy, type 1 and type 2 diabetes, glycemic control, stress hyperglycemia. The reference lists of selected publications were also searched. Certain articles that were not retrieved during this search strategy were added at the authors' discretion. The primary focus was on listing literature investigating the use of in-hospital CGM in non-pregnant adults, with the inclusion of high-impact clinical and analytical studies focusing on device accuracy and outcome data in different hospital settings as the general criteria. The screening process involved reading the title and abstract of each paper, as well as acknowledging landmark studies on in-hospital glycemia management. All selected articles were in English and peer-reviewed.

3. The Rationale for In-Hospital CGM Use

Individuals with diabetes or newly diagnosed hyperglycemia represent 20 to 30% of hospitalized adults in critical and non-critical care settings, either surgical or non-

surgical [6,12]. Historically, bedside capillary POC glucose monitoring has been the standard of care to assess glycemic control in the hospital. CGM provides a complete picture of glycemic trends, revealing periods of hyperglycemia, hypoglycemia, and glycemic variability that might be missed with intermittent fingerstick POC. Reducing the number of painful finger pricks improves patient comfort and contributes to different aspects of health-related quality of life [2–4], and lessens the workload of nursing staff [13,29].

The landmark Leuven surgical ICU study, published in 2001 [21], demonstrated improvement in outcomes with improved glycemic control in critically ill patients using an intravenous insulin infusion. The medical ICU trial in Leuven was unable to replicate the survival benefits observed in surgical ICU patients [30]. Similarly, the NICE-SUGAR trial, designed to investigate the effects of glycemic control in critically ill patients, showed that patients assigned to intensive glycemic control experienced worse survival and more hypoglycemic events [31]. These findings contradicted the original Leuven trial and opposed the trends toward very aggressive glycemia management. Umpierrez et al. observed that in-patient hyperglycemia in non-critically ill patients, with or without diabetes, is an independent marker of mortality and poor outcomes, especially with stress hyperglycemia [22]. These findings align with studies showing perioperative dysglycemia links to complications and higher mortality in non-diabetics [32,33]. Since surgery is a significant stress for the organism, disturbances in glucose regulation are common in the perioperative setting [34]. Better glycemic control improves outcomes, notably in cardiac surgery (e.g., wound infection, ventilation, ICU stay) [32,35,36]. Intraoperative hyperglycemia relates to infections after non-cardiac surgery [33,37]. Glycemic targets in non-critical in-patient care are less defined, with moderate goals preferred, avoiding hypoglycemia and tolerating hyperglycemia in selected populations [6,9].

Diabetes management has seen significant advances over the past decade, highlighted by the introduction of new non-insulin treatments, along with updated formulations of both daily and once-weekly insulins [38–40]. Simultaneously, diabetes technology has taken a leading role in self-management. Real-time CGM technology has progressed to the point where PwD can now use it to make informed treatment choices in outpatient settings [41–43] without the need to confirm glucose levels with POC testing [44]. There has been a notable increase in the use of CGM among PwD using insulin and the emergence of automated insulin delivery (AID) and closed-loop systems [4,45,46]. These developments coincided with the COVID-19 pandemic, which primarily affected critical care settings. In April 2020, the FDA temporarily allowed for the use of CGM in hospitals by exercising "enforcement discretion" during the COVID-19 pandemic. Although this temporary policy ended in November 2023, the FDA has maintained its position of "nonobjection" to the use of CGM in a hospital setting while it continues to evaluate the technology for full in-patient approval and updated labeling [5–7].

CGM devices with integrated advanced remote monitoring technology and alert systems are applicable in the in-patient setting, enabling proactive intervention and alleviating the constant fear of inducing hypoglycemia, which can deter caregivers from administering the necessary insulin doses to achieve optimal glycemic control.

4. Analytical Accuracy and Clinical Performance of CGM Devices

The accuracy of CGM devices when used in outpatients, as mainly assessed by the mean absolute relative difference (MARD), is generally comparable to that of traditional glucose meters [14]. The lower the MARD, the closer it is to the reference glucose values. It has been agreed upon that MARD below 10% is sufficient for outpatient clinical decision making without capillary glucose measurements [44].

CGM accuracy in everyday use is often lower than the metrics presented by the manufacturers and approved by the FDA. With multiple competing CGM systems now available, accuracy varies notably across brands [47,48]. A study by Freckmann et al. in Diabetes Care measured the performance of three popular systems (FreeStyle Libre 3, Dexcom G7, and Medtronic Simplera) and found quantifiable differences in key metrics [48]. Their findings confirmed measurable differences in key glycemic metrics, though the clinical impact of these variations and how they affect treatment decisions and safety needs further clarification. Furthermore, discrepancies in MARD performance are notable across device generations. A 2024 systematic review on CGM reliability [49] determined a high overall diagnostic accuracy of CGM devices, with an average MARD of 9.4%. Despite recent improvements, when evaluated against the strict ISO 15197:2013 criteria for classic glucometers, CGM performance varies depending on the glucose range [14]. While specific newer generations of CGM devices met the standard for hyperglycemia, no devices achieved the required accuracy for hypoglycemia. However, most devices evaluated with consensus error grids demonstrated over 99% accuracy in zones A and B (clinically accurate zones) for overall and hyperglycemic readings. Error grid analysis assesses the risk associated with the distribution of results [14]. In hypoglycemia, the average sensitivity (correctly detecting low glucose) was 86%, and the average specificity (correctly ruling out low glucose) was 95%. The accuracy was higher for hyperglycemia, at 97% and 96%, for sensitivity and specificity, respectively [49].

The skepticism surrounding in-hospital CGM use underscores the importance of recognizing factors that compromise sensor accuracy during an in-hospital stay [50]. Several factors have been identified as potentially influencing the accuracy of CGM in hospital settings [1,3,5,6,12–20,50], including the location of the sensor placement, the medications used, and fluid management. In principle, devices with calibration options appear promising in terms of achieving better concordance with the reference glucose level provided by POC [51]. Healthcare professionals and CGM users should be aware of potential interference from medications like high-dose acetaminophen, heparin, dopamine, hydroxyurea, and others that can affect sensor readings [13,14]. The reliability of continued CGM usage during radiology procedures (except for MRI scans) without interference in data transmission has been demonstrated [52,53].

Recent in-patient studies report a CGM MARD between 10% and 14%, while some researchers found MARDs well above, sometimes exceeding 20%. Notably, the worst performance was observed in the hypoglycemic range [54]. Regarding clinical performance, the Clarke-Parkes error grid analysis confirmed adequate clinical accuracy, with 98% of glucose readings falling into the clinically acceptable Zones A and B [53]. A primary pooled analysis of CGM data from 218 general medicine and surgery patients, non-critically ill PwD, found a median MARD of 10.1% [53]. This study also identified a well-known trend toward lower accuracy under specific conditions, e.g., during the first 12 to 24 h of sensor use, in cases of hypoglycemia with glucose values < 3.5 mmol/L; 70 mg/dL, and severe anemia with hemoglobin < 70 g/L [53]. Studies have shown reduced sensor accuracy and rapid fluctuations of glucose in extreme hypo- or hyperglycemia, compression of the sensor site, and in PwD who are critically ill. Poor perfusion may yield conflicting interstitial, capillary, arterial, and whole blood glucose values [42,55]. Pathophysiological states such as shock, severe edema, and hypoperfusion under high-dose vasopressors can create an ischemic environment at the sensor site, leading to an underestimation of the true plasma glucose level [42,55]. CGM systems differ primarily in their choice of enzyme, the electrochemical principle used to generate and measure the current, and the placement of the sensor. Glucose oxidase (GOx) is the predominant choice in commercially available CGMs due to its higher specificity to glucose and greater resilience to fluctuations in pH

and temperature [14,42,56]. The method used to measure the electrical signal (i.e., the current or voltage generated by the enzyme reaction) determines the generation of the sensor [14,42,56]. All commercially available implantable or subcutaneous CGMs measure glucose in the interstitial fluid, generating a physiological time lag, which is explained by glucose diffusing from the blood into the interstitium. This causes an average delay of 5–15 min between a change in blood glucose and the corresponding reading on the CGM [14,42,56]. The designation of a CGM device as an iCGM by the FDA signifies a high level of accuracy, reliability, and safety. Currently, this includes devices like the Abbott FreeStyle Libre 2 and 3 series and the Dexcom G6 and G7. For additional details, see Section 5.

While perfect accuracy is not achievable, the added value lies in the trend and directional information provided by CGM data [1,3,5,6,12–20].

Table 1 lists studies that focused on the accuracy of CGM use in hospital settings.

Table 1. Studies On CGM Use In Hospital Settings Published from 2023–2025.

Author (1.), Year	Study Design	Patient Characteristics	Clinical Setting	CGM System(s) Tested/Reference Standard	Key Accuracy Metric	Key Clinical Outcome and Conclusions
Ang L et al., 2024 [57]	Prospective cohort	59 postsurgical patients with hyperglycemia requiring insulin infusion	Cardiovascular ICU	Dexcom G6/ POC	MARD, Clarke error grid	MARD 13.2% Nurses reported CGMs being very or quite convenient, and it were favored over POC-BG testing
Avari P et al., 2025 [58]	Prospective cohort	10 PwT1D and T2D	undergoing hemodialysis	Dexcom G7/laboratory/ POC	MARD, DTS error grid	MARD CGM vs. laboratory 10.4%
Aziz QUA et al., 2025 [59]	Prospective cohort	22 patients with T2D after kidney transplant	Surgical ICU	NA	MARD, Clarke error grid	MARD 13.2%
Baker M et al., 2024 [60]	Prospective cohort	30 hospitalized patients requiring POC, 80% with T2D	General wards	NA	MARD, surveillance error grid, Clarke error grid	MARD 12.5%
Bann et al., 2024 [54]	Prospective cohort	28 adults (mixed diabetes and surgical)	Medical-surgical ICU	Dexcom G6/ laboratory	MARD, Clarke error grid	MARD 13.2% non-calibrated, MARD 9.6% calibrated—Calibration protocol improves accuracy
Chen AX et al., 2024 [61]	Prospective cohort	NA, hospitalized patients receiving insulin for prednisolone-associated hyperglycemia		Freestyle Libre Pro/ POC	MARD, Clarke error grid	
Finn E et al., 2023 [62]	Retrospective analysis	233 hospitalized adult patients	ICU, non-ICU	Dexcom G6/ POC/laboratory	MARD, Clarke error grid	POC-CGM MARD 17.1%, Laboratory-CGM MARD 12.2%, Real-world accuracy of in-patient CGM is acceptable for critically and non-critically ill patients

Table 1. *Cont.*

Author (1.), Year	Study Design	Patient Characteristics	Clinical Setting	CGM System(s) Tested/Reference Standard	Key Accuracy Metric	Key Clinical Outcome and Conclusions
Friman et al., 2025 [63]	Prospective cohort	40 ICU patients receiving insulin and organ-supportive therapies	ICU	Dexcom G6/ laboratory	Rate error grid	CGM demonstrated high overall trend accuracy relative to aBG. Trend accuracy was reduced at lower glucose ranges and during the initial 24 h of CGM use
Friman O et al., 2024 [64]	Prospective cohort	40 ICU patients requiring mechanical ventilation, insulin infusion, and vasopressor therapy	ICU	Dexcom G6/ laboratory	MARD, Clarke error grid	MARD 12.7%
Ge S et al., 2024 [65]	Prospective cohort	30 hospitalized PwT2D	General wards	Glunovo/FGM/POC	MARD, Clarke error grid	MARD 8.9%
Giovanetti et al., 2025 [66]	Retrospective analysis	35 critically ill patients requiring insulin infusion	Surgical and medical ICUs	Dexcom G7/ POC	MARD, surveillance error grid, Parkes error grid	MARD 12.5%, Clinician time efficiency improved significantly; all surveyed nurses (n = 20) reported that CGM increased efficiency and improved safety, and preferred CGM with POC over POC testing alone
Gu J et al., 2025 [67]	Prospective cohort	86 patients with hyperglycemia after cardiac surgery	Surgical ICU	Freestyle Libre/ laboratory	MARD, Clarke error grid	MARD 21.5% MARD aBG vs. vBG 8.4%
Insler SR et al., 2024 [68]	Prospective cohort	29 patients after cardiac surgery	Surgical ICU	Dexcom G6 Pro/ laboratory/POC	MARD, Clarke error grid	MARD 21.6%
Janssen H et al., 2025 [69]	Prospective cohort	118 surgical patients with or without diabetes	Perioperative, non-cardiac surgery	Dexcom G7/ laboratory	Overall mean difference (bias), MARD, surveillance error grid	MARD 12.0–18.3%
Krutkyte G et al., 2025 [70]	Retrospective analysis	29 adult patients	During and after major surgery	Dexcom G7/ laboratory	MARD, Diabetes Technology Society error grid, Clarke error grid	MARD during surgery 12.5%, MARD during ECC 15.5%, MARD after surgery 9.0% CGM system exhibits adequate accuracy with no signal losses during surgery

Table 1. *Cont.*

Author (1.), Year	Study Design	Patient Characteristics	Clinical Setting	CGM System(s) Tested/Reference Standard	Key Accuracy Metric	Key Clinical Outcome and Conclusions
Lee et al., 2024 [28]	Retrospective analysis	135 PwD, 28.6% with an insulin pump	ICU, medical or surgical wards	Dexcom G6, FreeStyle Libre 2, Medtronic/POC	Clarke error grid	Implementation of a hospital-wide in-patient CGM policy supporting multiple CGM types with real-time accuracy monitoring and integration into the EHR
Liu Y et al., 2024 [71]	Prospective cohort	40 ICU patients with acute respiratory failure	ICU	Freestyle Libre H/ Laboratory/POC	MARD, Clarke error grid	MARD CGM vs. aBG 13.8% MARD CGM vs. POC 14.7%
Moon et al., 2025 [72]	RCT	54 cardiac surgery patients (60% PwD, 40% non-diabetic)	Cardiac surgery ICU	Dexcom G6/ POC	TIR	CGM with a specialized titration protocol demonstrated safe glycemic control with improvements in TIR
Narasaki Y et al., 2024 [73]	Prospective cohort	31 PwD	on maintenance dialysis	Dexcom G6/ laboratory	MARD, Consensus error grid	MARD 20% Consensus error grids showed nearly all CGM values were clinically acceptable
O'Connor et al., 2024 [51]	Prospective cohort	326 PwD	Non-ICU medical/surgical wards	Dexcom G6 Pro/ POC/laboratory	MARD, %20/20, Clarke error grid	MARD 19.2% Lower accuracy in severe anemia, renal dysfunction and edema. Once-daily morning calibration schedule improved accuracy (MARD 11.4%)
Olsen et al., 2025 [74]	RCT	166 PwT2D	Non ICU	Dexcom G6/ POC	TIR	No heterogeneity of treatment effect was observed, suggesting that all patients benefited equally from CGM compared to POC glucose testing regarding glycemic outcomes
Price et al., 2023 [75]	Prospective cohort	76 PwD undergoing major surgery	Perioperative, general surgery	Abbott Freestyle Libre 2.0 and/or Dexcom G6/ POC	Pearson correlation coefficient	CGM provided more glycemic data and glycemic trends. The required time of CGM warm-up was a barrier for intraoperative use, as well as unexplained sensor failure

Table 1. *Cont.*

Author (1.), Year	Study Design	Patient Characteristics	Clinical Setting	CGM System(s) Tested/Reference Standard	Key Accuracy Metric	Key Clinical Outcome and Conclusions
Rivas-Montenegro et al., 2025 [76]	Pilot RCT	37 PwT2D	Non-ICU medical/surgical wards	Abbott FreeStyle 2/3/ POC	TIR, MARD, DTS error grid	TIR was higher, and more asymptomatic hypoglycemia was detected in the CGM arm MARD 14.7%
Sakjirapapong C et al., 2025 [77]	Prospective cohort	15 patients with COVID-19 receiving insulin	Non ICU	Medtronic Guardian Sensor 3/ POC	MARD, Clarke error grid	MARD 9.9%
Ullal J et al., 2025 [78]	Prospective multicenter cohort	130 adult ICU PwD or stress hyperglycemia receiving insulin	ICU, non-ICU	Dexcom G6/ laboratory TWO sensors placed!	MARD	MARD 23% The accuracy of the Dexcom G6 Pro sensor in the ICU setting was worse than has previously been reported
Voglova Hagerf B et al., 2024 [79]	Prospective cohort	61 patients after pancreas surgery or solid organ transplantation	Surgical ICU	Dexcom G6/ laboratory/POC	Overall mean difference (bias), MARD, surveillance error grid	MARD 9.4%
Wang et al., 2025 [80]	Multicenter retrospective observational	146 PwT1D	ICU, non-ICU	Modern CGM devices (not specified)/ POC/laboratory	MARD, consensus error grid	POC-CGM MARD 12.3%, Laboratory-CGM MARD 14.3% Modern CGM devices could be safely and effectively used in hospitalized PwT1D
Zelnick et al., 2025 [81]	Prospective cohort	12 PwD	on maintenance dialysis	Both Dexcom G6 pro and G7/ POC	MARD, DTS error grid	G6 Pro MARD 18.3%, G7 MARD 13.5%
Zhang R et al., 2024 [82]	Prospective cohort	NA, non-diabetic patients with esophageal cancer receiving postoperative EN	Surgical ICU	NA/ laboratory	MARD, Clarke error grid	MARD 13.5%

Abbreviations: ICU—intensive care unit, POC—point of care, BG—blood glucose, MARD—mean absolute relative difference, PwD—Person(s) with Diabetes, T1D—type 1 diabetes, T2D—type 2 diabetes, DTS—Diabetes Technology Society, NA—not available in abstract, FGM—flash glucose monitoring, ECC—extracorporeal circulation, EHR—Electronic Health Record, RCT—randomized controlled trial, aBG—arterial blood glucose, vBG—venous blood glucose, TIR—time in range, EN—enteral nutrition. Note: Where not specifically noted, the patient population was not defined (T1D or T2D).

Despite being influenced by factors including the number, range, and distribution of paired glucose values, as well as the rate of change in glucose values, MARD is an accepted accuracy metric for CGM [14,52,53]. Further evaluation of supplementary accuracy metrics, such as those proposed by the FDA for integrated CGM (iCGM) utilization in automated insulin delivery, may be necessary for the in-patient context as hospital protocols for CGM use continue to evolve.

5. Glycemic Discrepancies Between CGM and POC Measurements: CGM Lag Time and MARD Doping

The designation of a CGM device as an iCGM by the FDA signifies a high level of accuracy and safety. Currently, this includes devices like the Abbott FreeStyle Libre 2 and 3 series and the Dexcom G6 and G7. Achieving the iCGM designation involves meeting the most rigorous performance requirements to ensure these devices maintain high accuracy across the entire glucose spectrum [44]. To obtain this designation, a device must demonstrate accuracy across all glucose ranges with narrow confidence limits [44,83,84]. For hypoglycemia (measurements below 3.9 mmol/L; 70 mg/dL), over 85% of readings must be within 0.8 mmol/L; 15 mg/dL of the reference value, and importantly, over 98% must be within 2.2 mmol/L (40 mg/dL). In the time in range (3.9 to 10.0 mmol/L; 70 to 180 mg/dL), over 70% of readings must be within 15% of the reference, and over 99% within 40% [44,83,84]. For hyperglycemia (above 10.0 mmol/L; 180 mg/dL), over 80% must be within 15%, and over 99% within 40%. Across the entire measuring range, the device must ensure that more than 87% of all readings are within 20% of the corresponding blood glucose value. Beyond accuracy, safety requires that the device prevent catastrophic errors-meaning an iCGM reading indicating hypoglycemia cannot correspond to a reference reading indicating hyperglycemia, and vice versa [44,83,84]. Specifically, when iCGM values are less than 3.9 mmol/L; 70 mg/dL, no corresponding glucose value should read above 10.0 mmol/L; 180 mg/dL. The device must also reliably capture the glucose rate of change (trend accuracy), strictly limiting errors to no more than 1% where the iCGM shows a rapid positive or negative trend when the true trend is rapidly in the opposite direction [44]. Regulatory requirements extend to specific PwD populations and operational integrity: the manufacturer must provide data showing similar accuracy in the pediatric population as in adults and must be designed to have no clinically significant data gaps throughout its claimed sensor life, ensuring continuous communication of real-time glucose readings to connected devices via secure and reliable data transmission [44,83,84]. Finally, a successful usability study must confirm that the intended user can operate the device safely and accurately, and the product labeling must clearly detail the sensor's performance data, including accuracy across specific glucose concentrations, trend accuracy, and the frequency and duration of data gaps [44,83,84].

When CGM devices do not adhere to these strict standards, the manufacturers can present MARD values that are higher due to the special, non-problematic (non-diabetic) populations the CGM was used on, the most troublesome first day of the sensing was not included, etc. Such practices are referred to as MARD-doping [44,55]. Given the importance of these factors for patient outcomes, comprehensive and transparent studies that adhere to specific reporting standards—including peer review, clear population definition, specified testing protocols, and exact statistical analysis—are crucial for evaluating all CGM systems before approval. These standards, emphasized by researchers like Freckmann and Pemberton [55,83,84], are of utmost importance for the proper interpretation of accuracy data. In brief, a universally accepted method for assessing CGM accuracy is still needed to ensure clarity and quality.

Methodological Considerations and Limitations of Current CGM Evidence

Data from randomized controlled trials (including pilot as well as multicentre studies), prospective studies, observational studies, implementation studies, and systematic reviews/meta-analysis studies generally indicate that the use of CGM technology improves the detection of asymptomatic hypoglycemia and hyperglycemia, which in turn may improve outcomes in hospitalized patients [5,15,16,85]. Although recent studies underscoring the CGM applicability possess certain inherent methodological strengths (e.g., randomized

design), there are several limitations, such as small sample sizes (10 to 150 participants, exceptionally up to 230 participants in observational studies) and mostly single-center design of the studies reviewed. The majority of the studies carry a risk of bias related to specific patient populations, since the inclusion criteria specifically included only hospital wards where dedicated diabetes-trained personnel are based [86]. On the other hand, negative findings may be due to underpowered trials, the infrequent occurrence of certain outcomes in included CGM study populations, or the fact that CGM is a tool for monitoring care whose effectiveness depends on an appropriate response from hospital personnel (i.e., it detects problems, but does not solve them automatically). Only exceptionally, participants with additional challenges such as end-stage kidney disease, undergoing hemodialysis, and postprandial hyperglycemia in patients with glucocorticoid-induced hyperglycemia were included [87,88]. Several studies evaluating CGM used various reference standards, including POC capillary, laboratory, venous, or even arterial blood glucose, while some studies did not specify the reference standard [55,83]. Furthermore, studies do not uniformly specify whether the included PwD were Type 1 or Type 2, which makes generalizations of MARD and other outcomes difficult.

While most investigational studies focus on accuracy and safety concerns and aim to determine if CGM can be effectively used in the in-patient setting, only a few have examined the quality of glycemic control achieved with CGM compared to control methods without it. In this context, although the body of evidence regarding CGM use in hospital settings is increasing, it currently does not focus on the impact of CGM technology on clinical outcomes such as perioperative morbidity and mortality. Existing CGM clinical trials are often designed and powered primarily to detect differences in surrogate markers of glycemic management (e.g., time in range, hypoglycemia rates). As a result, they often lack the statistical power to identify small but clinically meaningful differences in hard outcomes, such as mortality.

Although CGM can be considered an intervention, it functions more as a process-of-care tool rather than a therapeutic agent. Its influence on complex outcomes like length of stay or infection is indirect and depends heavily on how well personnel respond to the data provided by CGM technology. The lack of observed improvement may reflect systemic healthcare challenges instead of a failure of the CGM itself. In-hospital mortality and length of stay are primarily driven by severe underlying illness and comorbidities, making it difficult for improvements in glycemic management—the main advantage of CGM—to significantly alter these complex, hard endpoints in moderately sized trials.

Table 1 compiles 29 studies that focus on the accuracy of CGM use in hospitals, identified according to the inclusion criteria described in Methods. Please note that where not specifically listed patient/study population was not defined (NA).

6. Review of Current Recommendations, Evidence, and Clinical Applications by Settings

In-hospital CGM use is still considered investigational, and CGM devices are not approved by regulatory agencies, such as the FDA and the European Medicines Agency (EMA), for in-patient use [5]. It has been suggested by many national guidelines that in PwD/hyperglycemia hospitalized in a non-critical care setting, both finger-prick POC and, where possible, CGM systems can be used [10]. In 2022, updated guidelines for managing hyperglycemia in hospitalized, non-critical care patients were published [6]. The updated version of the 10-year-old Guidelines on Management of Hyperglycemia in Hospitalized Patients in Non-Critical Care Settings [6,89] focused on ten key areas of diabetes care for in-patient populations; however, this update does not cover glycemic management for surgical patients, those on total parenteral nutrition, or the prevention and treatment of hypoglycemia [89].

Major guidelines for critically ill patients agree on using intravenous insulin infusion for hyperglycemia. Specific glucose targets vary by organization. Current guidelines, such as those from the Society of Critical Care Medicine (SCCM), suggest maintaining glucose levels below <10.0 mmol/L (<180 mg/dL), avoiding hypoglycemia, with a target range of 8–10 mmol/L (144–180 mg/dL) as preferred [90]. The American Diabetes Association (ADA) [8,9], Endocrine Society (ES), and the American Association of Clinical Endocrinology (AACE) recommend a primary goal of 7.8–10 mmol/L (140–180 mg/dL). The Australian Diabetes Society (ADS) supports a broader range of 6–10 mmol/L (108–180 mg/dL). All guidelines recommend frequent capillary glucose monitoring every 30 min to two hours, to maintain control and patient safety [10].

The most updated guidelines address the use of CGM, typically recommending its use for patients who are already familiar with the technology, cognitively unimpaired, when a specialized in-patient diabetes team is available for support [91]. The continued use of standalone CGM in established users or personal insulin pump—AID use in in-patient settings is supported across several diabetes guidelines, including those from the American Diabetes Association [9], the Joint British Diabetes Societies [92], the Diabetes Technology Society [93], and the Endocrine Society [6]. This practice is encouraged if two conditions are met: the patient has demonstrated competence in pump management, and there is appropriate supervision available from hospital personnel [10].

Table 2 synthesizes current recommendations from major international and national bodies and expert panels on the use of CGM in hospitalized PwD.

Table 2. Comparative International Guideline and Expert Panels Recommendations for In-Hospital CGM.

Guideline Body Latest Edition Guideline/ Consensus Document	Primary Focus Area	Recommended Strength	Recommended Target Glucose Range	CGM/Insulin Pump Stance	CGM Limitations/ Contraindications/ Requirements
American Diabetes Association (ADA) (*Standards of Care 2026*) [8,9]	Clinical practice guideline for PwD	Conditional; evidence-based (Grading of Recommendations Assessment, Development and Evaluation [GRADE])	**5.6–10.0 mmol/L = 100–180 mg/dL** • for non-critically ill • in the perioperative period within 4 h of the surgery. **7.8–10.0 mmol/L = 140–180 mg/dL** • for the critically ill in the ICU	**Continuation of personal CGM/AID systems use with Hybrid testing protocols:** • particularly for PwD at increased risk for hypoglycemia • if capable • with confirmatory POC measurements for insulin dosing and hypoglycemia assessment • proper personnel training and supervision No mention of **introducing CGM in-hospital**	• CGM should not be used alone for glucose monitoring during surgery • availability of necessary supplies • ongoing competency assessments • implementation of institutional diabetes-technology protocols
Endocrine Society (ES) (*2022 Update*) Korytkowski et al., 2022 [6]	Clinical practice guideline for non-critical care adult in-patients	Conditional; evidence-based (Grading of Recommendations Assessment, Development and Evaluation [GRADE])	**5.6–10.0 mmol/L = 100–180 mg/dL**	**Continuation of personal CGM/AID systems use** • particularly for PwD at increased risk for hypoglycemia • if capable • with confirmatory POC measurements for insulin dosing and hypoglycemia assessment • proper personnel training and supervision **Introducing CGM** for noncritically ill patients at high risk for hypoglycemia will vary by institution, if implemented, • a protocol for guiding the process is necessary	• robust protocols for personnel training, documentation, • integrating data into the electronic health record (EHR) **Discontinuation required**: • extensive skin infections, hypoperfusion, or hypovolemia, or those receiving vasoactive or pressor therapy • medications (e.g., acetaminophen > 4 g/day, dopamine, vitamin C, hydroxyurea)

Table 2. *Cont.*

Guideline Body Latest Edition Guideline/ Consensus Document	Primary Focus Area	Recommended Strength	Recommended Target Glucose Range	CGM/Insulin Pump Stance	CGM Limitations/ Contraindications/ Requirements
Joint British Diabetes Societies (JBDS-IP) (*Latest Guidance*) Avari et al., 2023 [92,94]	Scoping review and guideline summary for CGM in the hospital	Conditional; consensus-based, moderate evidence	**6.0–10.0 mmol/L = 108–180 mg/dL** • for acutely unwell • less than 1% time below 3.9 mmol/L **HIGH ALERT set at** **15–18 mmol/L = 270–324 mg/dL** **LOW ALERT set at** **4–5 mmol/L = 72–90 mg/dL**	**Continuation of personal CGM/AID systems use** • particularly for PwD at increased risk for hypoglycemia • if capable • with confirmatory POC measurements for insulin dosing and hypoglycemia assessment • proper personnel training and supervision No mention of **introducing CGM in-hospital**	**Discontinuation required:** • critically ill, hemodynamically unstable, or requires high-dose vasopressors • need to formalize how this information will be used to inform patient care
Joint British Diabetes Societies (JBDS-IP) (*Latest Guidance*) Avari et al., 2022, "Insulin Pumps and Hybrid Closed-Loop Systems" [11]	Scoping review and guidance for insulin pumps and hybrid closed-loop in the hospital	Conditional; consensus-based, moderate/low evidence	**6.0–10.0 mmol/L = 108–180 mg/dL** • for acutely unwell • less than 1% time below 3.9 mmol/L **6.0–12.0 mmol/L = 108–216 mg/dL** • elderly, frail **HIGH ALERT set at** **15–18 mmol/L = 270–324 mg/dL** **LOW ALERT set at** **4–5 mmol/L = 72–90 mg/dL** **LOOMING HYPOGLYCEMIA** **4–6 mmol/L = 72–108 mg/dL**	**Hybrid testing protocols:** • POC capillary BG at least twice daily • POC capillary BG should be performed to corroborate the result and treated as per local guidance	**Discontinuation required:** • critically ill, incapacitated, intraoperative hypotension/hemorrhage • Magnetic Resonance Imaging • Direct Current Cardioversion • during hyperglycemic emergencies • hypotension, hypothermia, hypoxia, vasopressor use, and • potential substance interference. The lack of a 24/7 diabetes team and infrastructure to support

Table 2. *Cont.*

Guideline Body Latest Edition Guideline/ Consensus Document	Primary Focus Area	Recommended Strength	Recommended Target Glucose Range	CGM/Insulin Pump Stance	CGM Limitations/ Contraindications/ Requirements
Diabetes Technology Society (DTS) (*Consensus Guidelines*) Galindo et al., 2020 [93]	Consensus guideline for Continuous Glucose Monitoring (CGM) and automated insulin dosing in the hospital	Strong/mild consensus; evidence- and consensus-based	No mention of targets	CGM can be used as a primary monitoring tool, often in a hybrid protocol with POC checks. Recommend continuation of home CGM for patients not cognitively impaired and capable of self-management	**Discontinuation required**: • hyperglycemic crisis • severe hypoglycemia • conditions with rapidly changing BG • cognitive impairment, inability to self-manage, severe metabolic decompensation, skin infection
Diabetes Technology Society (DTS) (*Consensus Guidelines*) Spanakis et al., 2023 [5]	Consensus statement on CGM metrics for in-patient trials	Strong/mild consensus; consensus-based	**5.6–10.0 mmol/L = 100 to 180 mg/dL** • most of the hospitalized patients) **5.6–13.8 mmol/L = 100 to 250 mg/dL** • clinical instability, high hypoglycemia risk, limited life expectancy **3.9–5.6 mmol/L = 70 to 100 mg/dL** • may be considered as **Time at High Risk of Hypoglycemia (THRH)** **THE HOSPITAL %TIR = 3.9–10 mmol/L = 70–180 mg/dL** achieved in • **50%: adequate-70%: optimal** • individualized clinically acceptable target glucose ranges according to hypoglycemia risk		Individualized clinically acceptable target glucose ranges may vary • separating the defined hospital TIR glucose range (70–180 mg/dL) from clinically acceptable glucose target ranges used for clinical care and in-patient glucose monitoring and interventions (i.e., CGM hypo- and hyperglycemia alert settings).

Table 2. *Cont.*

Guideline Body Latest Edition Guideline/ Consensus Document	Primary Focus Area	Recommended Strength	Recommended Target Glucose Range	CGM/Insulin Pump Stance	CGM Limitations/ Contraindications/ Requirements
Diabetes Technology Society (DTS) Tian et al., 2023 [95]	Meeting report	Consensus-based	No mention Mentions separate metrics of glycemia; • **The Glycemia Risk Index** **(GRI)** = single-number summary on a 0 to 100 scale of the quality of glycemia • **The Glycemic Ratio** = quotient of mean ICU BG and estimated preadmission BG, based on HbA1c.	Meeting topics • the integration of glucose and insulin data into the EHR • technologies for insulin pumps • skin physiology • regulation of diabetes devices • data science, • artificial intelligence, and machine learning	Cross-sector collaboration is critical to advance the state of EHR integration and interoperability: **iCoDE-1** (Integration of Continuous Glucose Monitoring Data into the Electronic Health Record) focuses on moving diabetes technology data from various devices into the EHR
Multidisciplinary expert panel (International) Shaw et al., 2024 [96]	Good practice points for CGM in the hospital	Consensus-based The document reviews evidence on hospital CGM use	No mention of targets	Topics: • potential benefits of CGM use for in-patients—Current knowledge • existing guidance for in-patient CGM use • analytical and clinical evaluation of CGM performance • quality assurance • regulations and accreditation standards for CGM use • barriers to CGM implementation in hospital settings	Factors to consider for safe use of CGM systems in hospitals: • personnel training • clinical workflow • hospital policies • integration of CGM data in the EHR • cost considerations

Abbreviations: ICU—intensive care unit, POC—point of care, BG—blood glucose, EHR—Electronic Health Record, PwD—Person(s) with Diabetes, TIR—time in range, AID—automated insulin delivery.

a. CGM In Non-ICU Settings

For in-patients with type 2 diabetes, studies have generally shown that CGM enhances the safety and efficacy of insulin administration compared to traditional POC testing [13,14,20,47,51,53]. Supporting this, recent randomized controlled studies have confirmed that CGM improves overall glycemic control and reduces the frequency and duration of hypoglycemic episodes, especially asymptomatic and nocturnal, compared to POC testing [76,97]. By providing real-time data and alerts, CGM has been shown to safely and effectively improve in-patient insulin management, resulting in a positive impact on glycemic outcomes. Specifically, studies have reported an increase in time-in-range (TIR) by 7–15% points, mainly by reducing time spent in hyperglycemia (TAR). Furthermore, the use of CGM was associated with reductions in hypoglycemia (TBR) and glycemic variability, which may contribute to fewer in-hospital complications and reduced total daily insulin dose [98,99]. A 2025 meta-analysis of six randomized controlled trials, evaluating the effect of adding CGM to POC glucose control in non-intensive care hospitalized PwD, established that the addition of CGM to POC testing for insulin dosing resulted in superior glycemic control and reduction in hypoglycemia compared to POC testing alone [100]. However, a 2025 randomized controlled trial comparing using CGM with standard glucose management at six academic hospitals, including adults with type 2 diabetes hospitalized in the non-ICU setting, did not manage to improve average glucose substantially [86].

Hybrid closed-loop systems offer a palette of benefits in hospital settings, and AID via sensor-augmented insulin pump seems promising. For current users with type 1 diabetes, such insulin pump options are almost logical [50]. Although research on AID in hospitalized type 2 diabetes began in 2017, reports have remained sparse ever since Gu et al. demonstrated that AID therapy in hospitalized PwD significantly reduced the time required to achieve glycemic targets as compared to multiple daily injections (MDI) [101]. This innovative approach was also used in a study of the Omnipod 5 system in the hospital for patients with type 1 or type 2 diabetes who were introduced to AID technology in the hospital setting [102–104]. This tubeless patch-pump with remote real-time CGM was demonstrated to be feasible with a median proportion of time spent in automated mode of 95% as well as effective, with a mean TIR of 68% $\pm$ 16% and minimal time spent in hypoglycemia. Importantly, these results were observed among a diverse population of hospitalized adults with type 1 or type 2 diabetes, with varied initial glucose control as measured by HbA1c, who were suffering from acute clinical conditions and even steroid use [104].

However, research on AID systems in the hospital setting remains limited, with much of the current evidence derived from trials conducted in the UK and Switzerland using the CamAPS system [102–104]. Recent studies are expanding our understanding of efficacy and safety. Two key studies have explored the effectiveness of AID in a hospital environment, examining the continued use of the Medtronic 670G and 780G systems in hospitalized patients with type 1 diabetes [102]. The latest model of Dexcom (G7) demonstrated accuracy even in PwD on hemodialysis [58].

See Table 1 for further details.

CGM can also be helpful when glucose uptake and metabolism are affected by foregut pathology, resulting in late dumping syndrome presenting as hypoglycemia. Its use was reported in pediatric patients undergoing antireflux procedures [105], in patients after esophagectomy [106], gastrectomy [107,108], and after bariatric surgery [109,110]. It remains to be established whether CGM could be used in other instances of nondiabetic hypoglycemia, possibly aiding in reactive or spontaneous hypoglycemia differentiation [111].

b. CGM in the Intraoperative Setting

A recent literature review by Lim et al. has identified 22 studies that reported on intraoperative CGM use [112]. The majority were prospective cohort studies, and two randomized controlled trials were included. Most studies were conducted exclusively in cardiac surgical procedures (11 studies), six studies exclusively in abdominal surgery, and the rest had mixed surgical populations. Overall, the studies show a high technical reliability of CGM systems and minimal adverse effects. The accuracy was reported in 18 studies. It was reported as MARD in 7 studies, as the mean bias in 4, and as both in 5 studies. It varied from excellent to MARD well over 15% which is considered the cutoff value where the accuracy of the method can be regarded as unreliable. Most studies used arterial or venous blood gas analysis, which is readily available and routinely used for BG analysis during surgery as a reference against which the accuracy of GCM was compared. In 4 studies, CGM was compared to POC capillary analysis only. It is not surprising that in these studies, no significant discrepancies were found between CGM and capillary POC. All four studies that showed a MARD over 15% compared CGM to arterial blood gas analysis, and all included only patients undergoing cardiac surgery with extracorporeal circulation (ECC) [113–116].

Although serious challenges to accurate glucose measurements are prevalent in the peri-operative setting, studies have demonstrated the feasibility of CGM use in states of impaired tissue perfusion, hypotension, and hypoxia. It is usable in ICU settings [79,117] even in patients receiving pressors [118], which is often the case in major surgery. Data on CGM use in non-cardiac surgical patients remains scarce. As seen in studies of cardiac surgical patients, the radically non-physiological state of ECC can pose significant obstacles to the accuracy of CGM use. However, whether this is the case in other major procedures that impose severe hemodynamic disturbances (e.g., major thoracic surgery or any surgery with significant blood loss) remains to be investigated. A recent systematic review by Putzu et al. [17] on peri-operative CGM use in non-cardiac surgery included 26 studies. Eleven of those included intraoperative CGM, 4 of them in bariatric surgery patients, 1 in kidney transplantations, 1 in esophagectomy, and the others in non-specified major surgery. The prevalence of diabetes in these studies ranged from 0% to 100%. The review reported on aggregate CGM readings regarding glycemic profiles (glucose levels, TBR, TIR, and TAR), but not on the concordance between CGM readings and standard POC measurements. Device-related adverse events were uncommon; however, device dysfunction was reported in approximately 10%.

c. CGM in the ICU Settings

Hypoglycemic episodes seem to be one of the main contributors to poor outcomes. It is not surprising, then, that CGM was used in the ICU very soon after the first commercially available devices were introduced in the 1990s [119]. It was used in an attempt to reduce hypoglycemia in the ICU and was reported in 2010 by Holzinger et al. [120]. A reduction in the rate of severe hypoglycemia was shown in critically ill patients in whom the now-discontinued Real-Time CGM device was used compared to standard care [120]. Several other studies have shown that CGM use can reduce the incidence of hypoglycemia as well as reduce exposure to severe hyperglycemia [121].

The use of CGM in critically ill patients faces specific challenges, such as fluid shifts, vasopressors, and other medications that can affect sensor accuracy. It has been shown that CGM use is not significantly affected during critical illness. A recent multicentre retrospective analysis did not show significant influences on the concordance between CGM and POC-BG testing in hypoxemia, acidosis, or hypotension [122]. A scoping review by Nielsen et al., published in 2024 [123], included 96 studies on the use of CGM in ICUs. Most studies were observational, conducted in adult patients and mixed ICU units. Most compared the accuracy of subcutaneous CGM to arterial BG sampling. They reported

a great diversity in accuracy reporting, with MARD being the most commonly reported measure. They also proposed that future studies should use a prespecified test protocol to enhance validity and facilitate the comparison of outcomes between studies.

The effect of CGM use on outcomes of ICU treatment, not only on glycemia parameters, has not been studied extensively yet. An exploratory single-center RCT allocated patients older than 65 years with COVID-19 and critical illness to either CGM or routine POC-BG measurements. Mortality was significantly lower in the CGM group, and the length of ICU stay was also reduced [124]. A previously mentioned review on peri-operative CGM use in non-cardiac surgery has included 26 studies with 1016 patients in which CGM was used in the postoperative ICU. No studies included in this review reported on outcomes [17]. Although the body of evidence on CGM use in ICUs is growing, it is currently focused on reliability and glycemic metrics, and further data on the effect on outcomes is needed.

d. CGM In Patients with Diabetic Ketoacidosis (DKA)

Diabetic ketoacidosis (DKA) management requires frequent glucose measurements, traditionally performed by POC [14,125]. This practice often necessitates admissions to the ICU and significant healthcare costs [18]. CGM could be an efficient alternative to hourly POC glucose checks, potentially optimizing DKA management by reducing the use of hospital resources and enabling earlier detection of hypoglycemia. However, the reliability of CGM technology in DKA has not been thoroughly established. Anecdotal reports and a study of 20 adult patients with DKA, involving a total of 334 paired glucose measurements, showed that 97% of the paired readings fell within Clarke error grid analysis zones A and B, indicating sufficient clinical and analytical accuracy, despite a high MARD of 28.6% [19]. A real-world study of adults with T1D demonstrated high concordance of CGM measures with BG during intravenous insulin infusions. Wang et al. advocated CGM use when treating in-patients receiving intravenous insulin infusions in this study of 56 hospital admissions, which included a high percentage of patients with DKA (52%). The investigators analyzed 736 time-matched glucose pairs, and the overall MARD was calculated to be 12.5% [126]. Additionally, the CGM's ability to provide earlier detection of impending hypoglycemia in this vulnerable patient population highlights its potential to facilitate timely clinical interventions and reduce the risk of missed care opportunities [19].

See Table 1 for key recent primary studies investigating in-hospital CGM use.

7. CGM-Derived Glycemic Targets and CGM Alarm Settings for In-Patients

There are scarce hospital guidelines defining CGM-derived glycemic targets or in-hospital TIR, the CGM-derived metric designed for long-term outpatient care. TIR has gained recognition for its ability to predict chronic diabetes complications; however, in hospital settings, its value is limited for short, dynamic periods. The outpatient TIR target is typically set at >70% of time spent in the range between 3.9 and 10 mmol/L; 70–180 mg/dL [4,92,127]. The primary priority in glycemia management for in-patients remains preventing hypoglycemia, followed by avoiding severe hyperglycemia.

Glycemic targets are individualized in the outpatient setting according to a person's prognosis, risk of hypoglycemia, and frailty, and the in-patient environment should be no exception to this rule. However, in general, for acutely ill patients, several societies or expert panels suggest a target CGM-derived metric TIR of 6–10 mmol/L; 108–180 mg/dL. For stable patients, an outpatient target TIR of 3.9–10 mmol/L; 70–180 mg/dL may be acceptable. Alarms on CGM systems should be used as safety nets to trigger action, rather than enforcing a strict glucose range. Setting alarms for narrower CGM-derived glucose hospital targets (e.g., 6–10 mmol/L; 108–180 mg/dL) could result in excessive

alerts. Instead, alarm thresholds should be set at a point where a medical intervention is clearly necessary to ensure patient safety [55,84,92].

See Figure 1 for suggested in-patient CGM-derived glycemic targets and alarm thresholds, based on the available expert opinions. Further research is needed and is increasingly being published to lay out a blueprint for clear implementation protocols to utilize CGM trend arrows, alerts, and alarms [92].

The In-Patient Clinical Protocols

There is general agreement in clinical guidelines that hospitalized patients should have their glucose levels checked at mealtimes and bedtime using traditional finger-prick POC tests. However, opinions on the use of CGM in the hospital setting are evolving. Hybrid protocols integrating real-time CGM and POC have been studied the most [5,15,16,85]. In clinical scenarios where glycemic excursions are most pronounced, or HbA1c is of limited value due to hemoglobin abnormalities, CGM could overcome such limitations [88]. A 2025 meta-analysis evaluated nine protocols for in-hospital CGM-led insulin titration, all utilizing a hybrid approach to guide glucose management. Trained personnel oversaw CGM-based insulin titration and glucose management in 5 protocols, with considerable variation in the detail provided by the reviewed protocols. CGM alarm settings varied widely between different protocols, with high glucose alarm thresholds between >13.9 and >22.2 mmol/L; >250 and >400 mg/dL, and low alarm thresholds between <3.9 and <5.0 mmol/L; <70 and <90 mg/dL [128].

Such titration protocols have been well accepted by the personnel as demonstrated by Olsen et al., where team members expressed a preference for having a protocol for CGM-based insulin titration and rated the protocol's usability on a 1 to 10 scale, with mean scores (SD) of 8.7 (0.9), 8.3 (1.4), and 7.4 (1.9) for basal, prandial and correctional insulin, accordingly [129].

Figure 1 visually illustrates the relationship between most commonly advocated CGM-derived in-hospital glycemic targets (e.g., 108–180 mg/dL) and how CGM alert thresholds (low and high) can be configured to manage hypoglycemia risk and alert clinicians effectively.

Discrepancies, whether physiological, analytical, or technical, between capillary glucose readings and those from a CGM are a recognized phenomenon in clinical practice, termed sensor lag time [20]. In situations of rapid glucose change, the lag time and drift undermine the steady-state assumption, requiring more frequent POC validations until glucose stability is reached [5,11,84,94,95]. Additionally, there is a high degree of variability between readings within and across CGM systems [83]. An acceptable level of variance, known as the %20/20 rule, has been established based on the reference standard for integrated iCGM devices. According to this rule, the absolute difference should not exceed $\pm$1.1 mmol/L ($\pm$20 mg/dL) when the CBG value is $\leq$5.6 mmol/L ($\leq$100 mg/dL), or it should remain within $\pm$20% of the CBG value if it is >5.6 mmol/L (>100 mg/dL) [84].

For additional details, see Section 5. When a significant discrepancy is observed, more frequent POC monitoring is recommended for several hours [5,11,84,94,95]. For CGM systems that allow calibration, a POC reading can be used to calibrate the sensor, and its accuracy should then be verified against the %20/20 standard. If the discrepancy continues despite these steps, the CGM device should be removed and replaced with a new one or discontinued completely, as suggested by current clinical consensus [92,94].

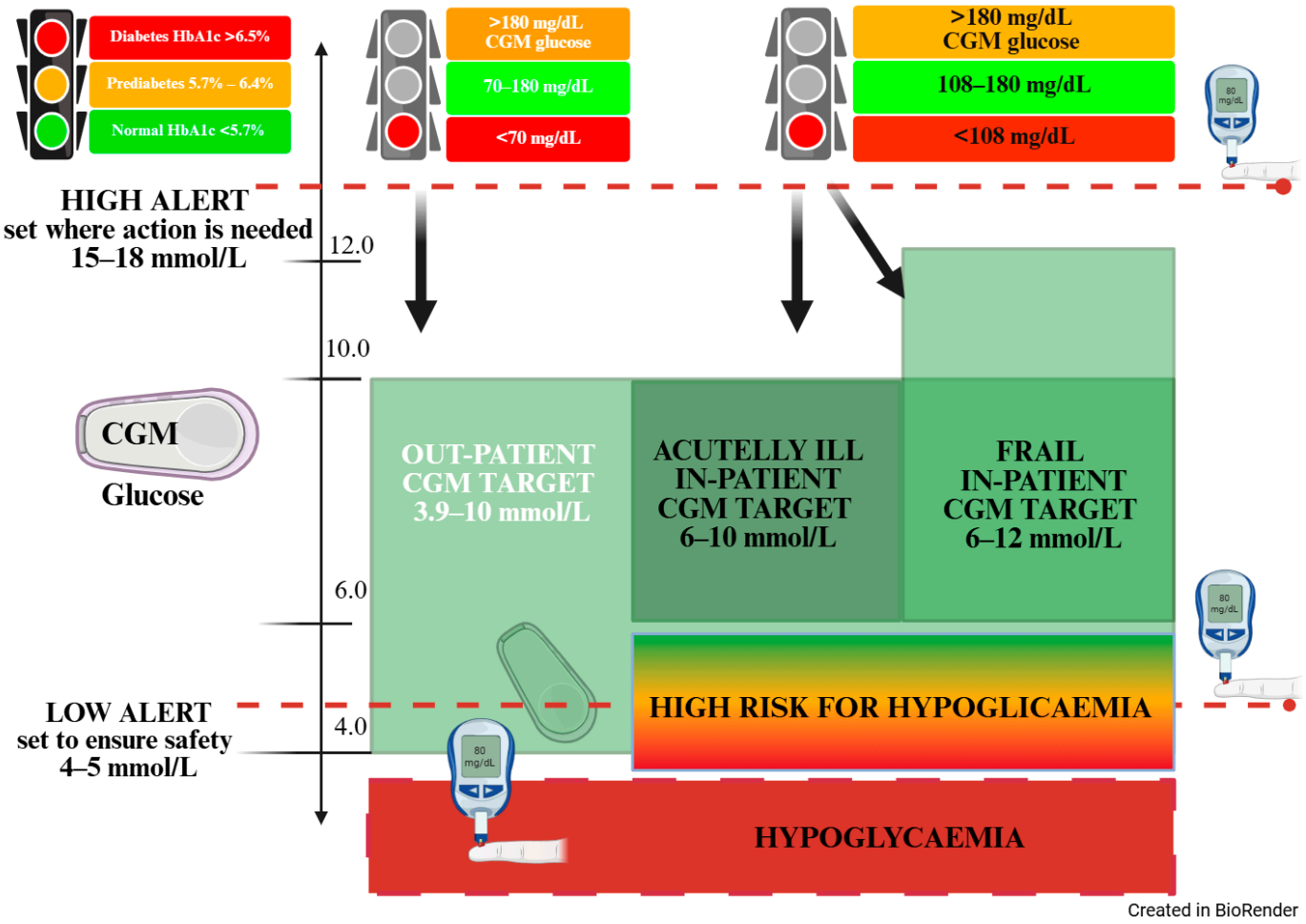

Figure 1. Guidance For In-Patient Glycemic Targets, CGM Alert Thresholds, And Suggested In-Patient TIR. Target CGM glucose ranges should be tailored individually, often using a hybrid protocol with POC checks. While the most common CGM glucose target for acutely ill in-patients is 6 to 10 mmol/L (108–180 mg/dL), the broader outpatient target of 3.9 to 10 mmol/L (70–180 mg/dL) may be more appropriate for well and stable individuals, such as those undergoing elective surgery. For frail in-patients, the goal should be to prevent hypoglycemia. More research is needed to determine suitable CGM metrics for the hospital setting. LOW Alert: For the acutely ill, a glucose reading of 4.0 to 5.9 mmol/L (72–106 mg/dL), combined with a downward trend, indicates impending hypoglycemia and requires prompt action. Abbreviations: CGM, continuous glucose monitoring; POC, point-of-care glucose testing.

Table 3 lists clinical situations where CGM inaccuracies are expected, and where current clinical consensus/expert opinions suggest POC confirmation.

Table 3. Situations implying the need for POC testing in hybrid POC-CGM in-hospital use.

Situation of Suspected CGM Inaccuracy	Need for Initial or Periodic POC Testing
Suspected Hypoglycemia	• confirmation of hypoglycemia • tracking recovery • symptoms are present, but the CGM reading is normal
Unreliable CGM Readings	• CGM glucose value appears to be erroneous • CGM glucose value is absent • the trend arrow is missing

Table 3. *Cont.*

Situation of Suspected CGM Inaccuracy	Need for Initial or Periodic POC Testing
Calibration Required by the Device	• confirmation of extreme readings • discordance between CGM readings and symptoms of hyper- or hypoglycemia • intermittent signal loss
During/Following Procedures	• labor/delivery • hemodialysis • radiology procedures • the event of hypotension or hemorrhage • hyperglycemic emergencies • post-surgery, or during/after cardiac arrest **CONSIDERATIONS, ADVICE:** – The CGM device should be placed away from the surgical site and any diathermy pad – CGM devices should be removed for external cardioversion (resuscitation should not be delayed) – Pump and CGM devices should be covered by a lead apron to protect against radiation exposure

Adapted from [5,11,84,94,95]. Abbreviations: CGM—continuous glucose monitoring, POC—point-of-care glucose testing.

8. Implementation and Future Directions

8.1. Practical Limitations and Constraints of In-Patient CGM Use

Real-time continuous glucose monitoring (rt-CGM) enables wireless transmission of recorded data to a central location, such as a monitor at a nurse's station. It can be achieved through a telemetry-like setup or CGM-specific dashboards [95]. Implementation studies reported feasibility and high user acceptance among personnel and patients [130]. Integration with Electronic Health Record (EHR) and protocols was reported as achievable, with remote monitoring also minimizing personnel exposure in infectious disease settings [7,28,131–133]. However, a hybrid protocol, which utilizes POC and CGM measurements, is still the most commonly used [128], as the MARD sufficient for in-hospital CGM use without confirmatory POC testing has not been established.

8.1.1. Technical and Analytical Limitations

Hospitals are encouraged to establish a formal policy, subject to regular reviews, that governs the use of wearable diabetes technologies within the in-patient setting, clearly specifying whether it involves a standalone CGM (continuation of personal device use or new patient onboarding) or an AID system with a hybrid closed-loop setup [11,96,134]. Furthermore, integrating diabetes technology with EHRs should be systematically addressed [11,96,134]. Cross-sector collaboration is critical to advance the state of EHR interoperability [135], as the framework model of iCoDE-1 (Integration of Continuous Glucose Monitoring Data into the Electronic Health Record) suggests that diabetes technology data from various devices merge into the EHR [95]. Currently, since CGM devices do not directly integrate with EHRs, the diabetes care team must access the patient's glucose data with their consent either through the mobile app's remote-sharing feature or directly via the device's "history" feature [92]. There is also a pressing need for comprehensive training for nurses, physicians, and other healthcare professionals on interpreting and responding to CGM data, including trend arrows and alarm settings [11,96,134]. Preferably, policies regarding the utilization of technology in hospital settings should be subject to annual review to incorporate CGM use into existing clinical workflows without adding a significant burden, thereby avoiding personnel fatigue and information overload [11,96,134].

8.1.2. Operational and Implementation Challenges

The use of CGM by PwD with type 1 or 2 in the outpatient settings, either as a standalone CGM with MDI or AID therapy, has been evaluated as a cost-effective approach when compared with standard care involving self-monitoring with finger-pricks [2–4]. Evaluating the financial impact of adopting CGM in hospitals requires balancing the initial costs against the potential long-term benefits. The costs of implementing CGM extend beyond just the technology itself and include the price of the devices, as well as the expenses associated with integrating the system into the EHR [95]. Additionally, there are costs related to training personnel and implementing the CGM program, which include developing protocols for cybersecurity and quality assurance with health indicators [11,96,134,135]. Ultimately, these costs may be offset by significant financial benefits, including improved patient outcomes such as a reduced length of stay, fewer in-hospital complications, and lower readmission rates. So far presented cost comparison of POC glucose measures versus CGMs for insulin infusions implies this could result in cost savings when intravenous insulin infusion is needed for more than 24 h [95]. GCM use has been proven to enhance productivity and demonstrated significant improvements in workflow efficiency [130].

8.2. Future Directions

For in-patient diabetes care to be further improved, research is needed regarding the applicability of CGM, particularly in areas where current guidelines are either limited or inconsistent. To fully embrace the clinical potential of CGM in the hospital, the field must first establish clear, standardized, evidence-based protocols for its application in ICU as well as non-ICU settings, and reach a consensus on safe MARD thresholds required for effective and secure in-patient use [13]. A universally accepted method for assessing CGM accuracy is still needed to ensure clarity and enhance glycemic results [44,83]. Furthermore, achieving scalable integration relies on the seamless flow of CGM data into EHR and remote monitoring platforms, a step essential for enhancing workflow efficiency and maintaining high standards of patient safety [136].

It remains to be established whether the benefits of in-hospital CGM use persist after hospital discharge. A study by Umpierrez et al. revealed a trend toward improved glycemic control in the CGM group compared to the capillary POC testing, including improved TIR, decreased TAR, fewer hypoglycemia episodes, and lower insulin requirements 12 weeks post-hospital discharge [137]. However, there were no significant differences in hospitalizations or emergency room visits between study groups [137].

Finally, interest is growing in the use of CGM in individuals with dysglycemia who have no prior history of glucose intolerance. Hospital settings with altered nutrition and stress-induced hyperglycemia often pose challenges to tight glycemic control using conventional treatment tools [138]. Advanced diabetes technology has the potential to improve outcomes in hospitalized individuals without diabetes who exhibit dysglycemia [139]. Such profound insight into glycemic excursions during stress hyperglycemia could assist in our understanding of underlying factors (sympathetic stimulation, rise in stress hormones, disproportionate release of inflammatory cytokines) and ways to counteract this, e.g., as advocated by the enhanced recovery after surgery (ERAS) protocol [140]. Additionally, CGM use could add particular value in certain conditions, such as nutrition therapy or peri-operative and postoperative management [141] in individuals with foregut pathology, and after bariatric surgery, resulting in late dumping and other hypoglycemic episodes [109,110].

9. Conclusions

CGM is a rapidly evolving and promising technology with the potential to transform in-patient glycemia management once it demonstrates sufficient evidence of accuracy and safety for official approval. Using real-time monitoring during hospital stays is an effective and safe method to guide insulin therapy, as it has generally been shown to reduce recurrent hypoglycemic events compared to intermittent POC testing. CGM appears feasible even in more extreme situations, such as in the intraoperative and ICU care. Despite challenges related to implementation, including personnel training and costs, the benefits of improved monitoring and in-patient safety make CGM a worthwhile technology to pursue. An increasing amount of evidence highlights the growing importance of CGM in modern hospital care.

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